

AD-622 096

A NEW LOOK AT THE DESIGN OF LOW-
BUDGET CIVIL DEFENSE SYSTEMS

By

William M. Brown

HI-478-RR

August 2, 1965

Prepared under Contract Number
OCD-PS-64-116 for the Office of
Civil Defense, Department of the
Army, Washington, D.C. 20310
Work Unit 4211-B

This report has been reviewed in the OCD and
approved for publication. Approval does not
signify that the contents necessarily reflect
the views and policies of the OCD.

Distribution of this document is unlimited.
Copies of this report may be obtained from
Defense Documentation Center, Cameron Station,
Alexandria, Virginia, 22314.

HUDSON INSTITUTE, INC.
Quaker Ridge Road
Harmon-on-Hudson
New York 10520

Best Available Copy

TABLE OF CONTENTS

	<u>Page</u>
SUMMARY.	iii
I. THE PHILOSOPHY OF THE "NEW LOOK"	1
II. CRISIS CONTEXTS.	7
III. URBAN VULNERABILITY.	11
IV. SPONTANEOUS DISPERSAL OF URBAN POPULATION.	15
V. A BALANCED FALLOUT SHELTER PROGRAM	17
Balancing PF Requirements	17
VI. DYNAMIC PLANNING FOR EMERGENCY CD.	21
Strategic Warning Period.	22
After Tactical Warning.	24
The Shelter Period.	25
The Emergence Period.	27
Resources for Recuperation.	29
VII. LOW-CASUALTY DESIGNS	31
VIII. CD EFFECTIVENESS	35
REFERENCES	37

LIST OF TABLES

Table I	Some CD Alternatives for Crises	8
Table II	"Secondary" Sources of Urban Vulnerability.	11
Table III	Dose Contours for a 1-MT Fission Groundburst.	17
Table IV	Dynamic CD Planning--Some Options	22

SUMMARY

In designing any military system it is important to consider large ranges of criteria and objectives. In practice, however, it is often difficult to gain acceptance for the system unless a single "design situation," embodying a particular choice of criteria and objectives, is selected, while the remaining situations are treated as "important but off-design" cases. It is argued that civil defense planning in the past has in effect accepted surprise attack out of the blue, with substantial megatonnage directed at cities, as its "declaratory design case." Surprise attack out of the blue with the initial salvo directed at strategic forces has been the "action design case" for important recent studies. It is suggested that a better "design" situation would be the tension case which allows extensive emergency readiness procedures (with either a counterforce or mixed attack). While this choice might lead to some neglect of the off-design surprise-attack cases, it is argued that the consequences of such neglect can be guarded against and partially offset.

If this point of view is adopted, highly effective civil defense systems could be designed on almost any reasonable budget level (for example, as low as \$1/10 billion a year), so long as the effectiveness of such programs is evaluated primarily on the basis of performance in what we consider to be the most likely, or most important case, that is, one in which extensive movement of the urban population is possible. For such a case, the design of the system would set a goal of zero casualties, even against moderate-sized mixed attacks. However, the plans and preparations would be such so as to make appreciable protection available in the case of other attacks and off-design situations. Of course the ideal implementation would not be obtained even in the case of the design attack, because of the many uncertainties, imponderables, and inefficiencies that must be expected to occur. Thus, these systems might be described as "low-casualty" in terms of expected results, or as "zero-casualty" in terms of design criteria. This paper is concerned with the performance of such low-casualty or zero-casualty designs in terms of the basic strategic situations mentioned above.

Basic to any design would be plans and preparations (consistent with the budget) which, if one of the design scenarios occurred and the plans were implemented in a timely and proper fashion, would offer every civilian almost complete protection against a spectrum of nuclear attacks in which both military installations and urban centers were targeted. In this philosophy the higher budget programs are useful because they (a) reduce the sensitivity of the design to required warning, (b) extend the range of possible nuclear attacks against which the system would be effective, and (c) increase the number of options for handling unanticipated needs for protection. At higher budgets the estimated number of casualties for a design situation and a reasonable implementation would be considerably smaller and there would be a correspondingly higher confidence in the probability of obtaining an effective implementation across a wide range of off-design scenarios.

Thus, this study concludes that while a current federal program provides high-quality protection against purely counterforce attacks, an extension of this program and its ongoing research effort to CD designs which exploit warning against urban attacks now appears to be feasible. Such an extended program could achieve an astonishingly low vulnerability against the known effects of nuclear attack.

After an initial discussion of the philosophy behind low-casualty designs, the subsequent sections of this paper develop the following themes in greater detail:

1. The range of interesting international crisis contexts and their implications for the design of CD programs.
2. The vulnerability of fallout shelters in urban centers during future crises when there is believed to be insufficient protection.
3. The possibility of spontaneous movement out of urban centers during future crises when there is believed to be insufficient protection.
4. The use of a balanced fallout protection concept for decreasing vulnerability to residual radiation.
5. A "dynamic" civil defense concept based on the idea of planning to improve protection at every time period before, during, and after an attack.
6. Some ways in which current estimates of the effectiveness of civil defense measures can be improved.

I. THE PHILOSOPHY OF THE "NEW LOOK"

It is not extravagant to say that the general public anticipates that in the event of a nuclear war in which weapons are used against our urban centers, the country for all practical purposes would be doomed. The estimates of the immediate fatalities which are generally offered are something like 100 million or 150 million with little hope for the survivors. These beliefs are supported by congressional testimony which, as recently as February of this year, asserted that a nuclear attack against this country would lead to about 140 million fatalities without a special damage-limiting system. This testimony (by Secretary McNamara) went on to say that if 25 billion were spent on active and passive defense the number of fatalities could be reduced to about 40 million.

We would like to define highly effective damage-limiting systems as those which could provide about 10 times the protection indicated by the previous numbers. That is, in the design case and in an important range of off-design cases, the expected fatalities would be between 4 and 15 million rather than 40 and 150 million; and only in very few of the off-design cases might such systems do less well than those assumed in Mr. McNamara's testimony. This paper will argue that such effectiveness in damage limitation is feasible because through civil defense planning that exploits likely warning time there is an approach to the designs of protective systems which in their effectiveness would appear to be startling not only to the general public but to many segments of the Pentagon. This is what is meant by the term, "The New Look," in the title of this paper.

Stated most starkly, the New Look is a "philosophy" of protective design which asserts that, even at low budgets, the ideal goal of a properly designed system should be zero casualties; i.e., it is worthwhile to try to set as a design goal that no civilian be a victim of a nuclear attack, even one in which hundreds of weapons were directed against the large U.S. cities. Realistically, of course, it should not be expected that this goal will be entirely achieved. However, although this ideal goal could not be obtained in any actual implementation by using the designs, we expect that civil defense systems can be made "highly effective" in the sense of the definition given in the preceding paragraph.

Conceptually the approach is not at all difficult. For a given set of scenarios, which straddle an important range of attacks (if not all of the important range), we can ask what the vulnerability would be at any location in the U.S., and then ask what can be done about substantially reducing the vulnerability of a person residing there. The answers to such questions determine the bases for attaining highly effective CD postures. It is obvious that one solution could involve the installation of high-quality blast shelters in or near all target areas. However, because of the higher costs required, blast shelter postures are assumed to be beyond the scope of this work, which is restricted to low-cost systems. Without blast shelters, attacks against urban centers would result in great numbers of casualties unless there had been a timely relocation of the vulnerable

population to shelters beyond the lethal range of megaton weapons. (It is assumed that active defense cannot provide the reliable protection required for a highly effective design.) Thus it will not be surprising to find that the programs generally would have options for movement of the vulnerable population and preparations for acquiring adequate shelter for them. Both these options may be expected to be feasible to such a degree that they make possible the design of (ideally) zero-casualty systems; reasons for this conclusion are considered subsequently.

A highly effective CD program implies that there exists a survival plan for every civilian which makes it very likely for him to survive under any of the spectrum of nuclear attacks for which the system was designed (and not too unlikely for him to survive in off-design cases as well). From this follows the notion of zero casualties which, as stated above, must be modified for a realistic appraisal of vulnerability.

Since the CD postures we are considering have been designed to eliminate all known vulnerabilities for a set of attacks, it will be argued that the estimates of casualties for the postures we are considering can be largely reduced to those which can be attributed to uncertainties, imperfections, and inefficiencies, if any (e.g., imprudent behavior, unforeseen bottlenecks, untimely decisions). In other words, because of ignorance, human error, and chance factors, some parts of the system must be expected to fail, thereby resulting in casualties. However, as we will show, the CD system can anticipate and prepare options to offset some of these difficulties. The determination of the quantitative degree to which this can be done is expected to be a matter for much future research. Some preliminary estimates of the effectiveness of some of these measures are made in section VI.

Using the estimated vulnerability of the civilian population as a measure of civil defense effectiveness, it is clear that even with low-casualty designs, there must be trade-offs possible between expenditures for CD and other variables such as:

- a. the spectrum of war scenarios as defined by:
 1. the durations and varying "credibility" of the preattack strategic warning period,
 2. the over-all size of the attack,
 3. the number and type of weapons;
- b. the confidence in the performance of the system;
- c. effectiveness (the estimated casualties) for any given attack.

Thus, with a greater amount of preparation it is expected that the range of scenarios which can be handled will be greater, and/or the confidence in the performance of the system increased, and/or the civilian vulnerability reduced. We will try to shed some light on the quantification of

these trade-offs by some discussions throughout this report. The expected performance of the system will be determined by the likelihood that war will break out in a "design" mode or "off-design" mode, and if in the design mode by our ability to estimate these factors.

Anticipating some of the main features of the subsequent analysis, the "design cases" to be discussed will be constrained by or require:

- a. War outbreak scenarios which exclude either surprise attack or very short warning to an unprepared civilian population.
- b. Timely relocations of any vulnerable urban population to non-target areas.
- c. "Balanced Fallout Protection" in non-target areas, obtained through appropriate use of existing shelter facilities, expedient construction, and improvised protection, where necessary.
- d. Willingness of government to mobilize available resources and labor (approximately 100 million workers) during a preattack emergency to improve the degree of protection until it is adequate or the crisis ends. (Note: it is unlikely that any state of protection will be judged adequate while a very tense crisis continues.)
- e. Plans which provide options for handling unusual requirements for additional protection before, during, or after an attack.

The next six sections of this study will deal with some of the major elements for the design of low-budget civil defense systems of high effectiveness. They will be concerned with the following themes:

1. For an important set (or even the most important set) of contexts or situations which could develop into a general nuclear war, there would be sufficient time provided by strategic warning to complete the planned emergency improvements to the CD posture.

2. Against city attacks, the probability of survival in urban fallout shelters is too low to make the use of such shelters advisable for the urban population. Not only would such a course be inconsistent with a low-casualty design, but, it will be argued that because of some secondary vulnerability considerations, the urban vulnerability is greater than is often estimated.

3. During a very severe crisis there is a substantial probability that a spontaneous evacuation would occur in the large urban centers if a reliable federal plan for urban protection were not in evidence. To the extent that this would be true, federal CD operations in the emergency would become involved with the various aspects of large-scale population movements whether or not they had planned for them.

4. On a national basis, to achieve a low-casualty system the posture would be based on a Balanced Fallout Protection concept, one which attempts to provide in every community the minimum fallout protection required for survival. This concept suggests the use of many of the current NFSS shelters in addition to other resources available in non-target areas. Such additional resources might include: (a) structures whose current PF's do not meet the NFSS standards; (b) basements in residences; (c) mines, tunnels and caves; (d) ships and boats; (e) preparations for the construction of expedient or improvised shelters.

5. Plans and preparations are feasible which not only enable a mobilization of civilian resources during a preattack crisis but which also can continue protective activities; (a) after tactical warning is received, (b) after shelter is taken, (c) after emergence from shelter. That is, a dynamic CD system would prepare a set of options to assist the struggle for survival during every period in which a threat might exist--before, during, and after an attack. The preparations appropriate to these options would, in most cases, be determined by an examination of local resources and requirements.

6. Since the designs anticipate removing people from the vulnerable target centers they are primarily concerned with accidental or collateral (i.e., unintentional) casualties.* This reduces the over-all nonmilitary defense problems to those of: (a) optimizing the CD system to reduce the collateral damage, (b) coping with the potential hazard of unexpected surprises and of bizarre scenarios (e.g., surprise attack, malevolent retargeting to strike rural areas, pindown attacks to prevent population movement), and (c) the problems of recovery and subsequent economic and social recuperation.

A few words are in order about the NFSS, the heart of the current federal CD program. Since this paper addresses itself to CD systems which assume that very effective protection against mixed attacks is needed or desired, it assumes a different policy from that which is needed to justify the NFSS. In our view a sufficient justification for the NFSS is that it provides very substantial protection against those nuclear wars in which cities are not attacked. In addition, government studies estimate that it can save tens of millions of lives when cities are attacked (Ref. 19). Counterforce operations which do not subsequently escalate into attacks against population centers are thought to constitute a substantial portion of the future strategic war possibilities. Thus the criticism which is frequently directed against this program, that it does not sufficiently protect the urban population if an enemy attacks our cities, is not germane to the argument. For this kind of protection an expansion of the current program into one of greater capability is needed, and indeed, is the subject matter of this paper.

*Of course, we must also take into account the possibility that the Soviets or Chinese would deliberately target the "evacuees." It is difficult, however, to find plausible purposes of an enemy that would be better served by striking at evacuees than at empty cities or force targets.

As an aside it may be mentioned that experiences gained through war gaming generally suggest that large-scale nuclear attacks against cities are not a rational option at any early stage of a general nuclear war,* although the possibility cannot be precluded that unforeseen developments would cause rational control to be lost during the course of the war or the Soviets might find themselves somehow "locked in" to their declaratory policy. (See Ref. 8, pages 180, 217-220. Also see Ref. 17 for some discussion of the development of attacks in war games.) For those scenarios in which control is not lost, the probability of the large urban attack would appear to be greatly diminished and, correspondingly, the utility of the NFSS posture is very high.

The argument that the current program, an inexpensive standby system, does not offer good protection against city-busting nuclear attacks seems analogous to the argument that seat belts on airplanes are undesirable because they are not effective against mid-air collisions. It seems more reasonable to enumerate the plausible contexts in which the NFSS has good utility. In this way we can compare its cost-effectiveness with other alternatives to determine its utility. If we should then wish to add a measure of good protection against the threats of deliberate or accidental city attacks we might wish to extend or modify the system. In this event, the current program should provide a springboard from which to develop the new program more effectively.

*We use the word "rational" here to mean that a decision-maker would not choose a course of action which calculations led him to believe would lose more than one third of his population.

II. CRISIS CONTEXTS*

Strategic studies hitherto have almost uniformly considered contexts in which little or no short-term improvement is anticipated in the CD posture or the recuperation capability. Yet, realistically speaking, the relatively sudden war or "strike out of the blue" is generally believed by analysts to be a far less likely eventuality than war emerging from an extended preliminary crisis. If, in the past, studies could plausibly emphasize surprise attack because they postulated a more or less uniform state of tension existing between the U.S. and the U.S.S.R. and relatively vulnerable strategic forces which tempted surprise attack, they do not accord well with current conditions of détente and relatively invulnerable strategic forces.

Thus, the most interesting and most likely situations, and the ones which could be most affected by advance preparations are the ones most neglected in planning. If one agrees that general war is very likely to arise from a period of international tension followed by intense crises** (but not necessarily following the most intense crisis), it should be observed that there might be enormous differences between CD systems which anticipate these conditions and those which do not. Nevertheless, such a criterion for evaluating and discriminating among alternative CD systems or postures is almost never used in current studies.

Whether one argues for increased readiness CD programs on purely prudential ground or out of more general strategic considerations, it does not constitute a decisive objection to mention the risk: (1) that we may not experience the prewar tensions sufficient to complete the preparations implied by the programs, or (2) that an attack might occur before they could be substantially actuated. As in deterrence strategies, the justification for a CD program includes a hope that it will not have to be used, a reluctance to rely upon the hope, and calculations of its expected utility in various attacks.

In effect, emergency readiness may bear a similar relation to the distinction between détente and cold war crises that the normal posture bears to the distinction between peace and war. The purpose of the suggested programs is both to help deter crises and tension situations and to alleviate the consequences if this deterrence fails.

Proper designs need not upset the current atmosphere of détente; on the contrary, they could reassure those in the NATO alliance who fear the détente (because it could lead to an erosion of Western capability) without disturbing the present Soviet incentives to develop it. Furthermore, such programs carefully and professionally carried through--with attention

*This section is largely a condensation of a portion of Ref. 1, revised somewhat for the special purpose of this paper.

**The word "intense" is used here to describe a crisis intense enough to dispel nuclear incredulity. Operationally we could define it as a crisis intense enough so that 20% of New York's population left the city because of fear of nuclear bombing (assuming the president does not discourage the movement). By this definition, we have never had an "intense" crisis.

to effects on U.S. citizens, allies and opponents--could substantially increase the capability of a U.S. president to act calmly and effectively during a crisis without simultaneously motivating the Soviets to pre-empt. Examples of how escalation might be affected by emergency readiness preparations, however, cannot be ignored. In any tense situation an act showing firmness or resolve may cause the opponent to attempt to pacify (e.g., Soviet response in Cuba) or escalate (e.g., U.S. response in the Gulf of Tonkin). These judgments would need to be made in the crisis. (For more discussion, see Ref. 8.)

To illustrate the argument, we define in Table I five conceptual levels of crisis CD tactics appropriate at various levels of international tension.

TABLE I
Some CD Alternatives for Crises*

<u>Programs</u>	<u>Estimated Time Available</u>
A. Increased Readiness Action**	(0 - 6 months)
1) Desperate	(1 hr. - 7 days)
2) Crash	(2 days - 2 weeks)
3) Emergency	(1 week - 6 months)
B. Mobilization Action	(3 months - 2 years)
1) Wartime	(3 months - 1 year)
2) Peacetime	(6 months - 2 years)

Both of the above classes of program should be compared with normal programs (3-7 years) and moderately accelerated programs (1-4 years). The principal distinction between the two classes of program listed above, increased readiness actions and mobilization actions, is the estimate made of the imminence of a possible nuclear attack.

Increased Readiness Programs would differ from Mobilization Programs in tending to disregard postemergency values, emphasizing short-term capability at the cost of normal procedures, and risking waste and inefficiency. A Mobilization Program is more sensitive to questions of cost and efficiency and the needs of competing programs, especially military ones. The Mobilization Program prepares for prolonged tension, siege, or low-level war. It is prudential in the sense that it tries to prepare for the future, possibly even at the risk of some short-run increase in danger, by adopting protective measures appropriate to the degree of international tension.

*An earlier but similar version of Table I will be found in Ref. 2, Chapter IV.

**Two years ago a Hudson Institute study estimated that with appropriate plans, proper motivation, and good leadership, American resources are sufficient that in two days' time it should be possible "to develop more civil defense capability during this time than has been obtained during the fifteen years following World War II." (See Ref. 2, Chapter IV, p. 7.) That estimate does not seem to need revision because of the civil defense capability that has been added in the last two years.

Of the three Increased Readiness Programs, the "Desperate" program may respond to a state of national anxiety equivalent to that which might be found on a battlefield. Either bombs have already exploded in the U.S. or are expected in a matter of hours. The program is termed "Desperate" in the belief that U.S. decision-makers would be willing to accept large risks in human lives and pay little or no attention to immediate material costs in order to achieve the highest degree of protection possible for the threatened citizens. Thus, in this kind of crisis, authorities (if an urban relocation plan were being implemented) would overcrowd railroad boxcars to transport urban citizens to safer areas, even to the point of risking some deaths. Large amounts of property could be destroyed to provide protective construction. Doors, fences, garages, barns, and interior walls would be torn down readily for building material. The government might attempt to evacuate perhaps 90-95% of the population of potential target areas.

The "Crash" program differs from the "Desperate" program in being less associated with terror, although sacrifices in procedure and cost are again accepted. But actions which would involve unusual human risks or extremely high economic costs would be avoided where possible. Urban relocation, if part of the plan, would be less hurried; most industries would shut down properly; and consideration would be given to the problems of assisting postattack recovery efforts.

Finally, the "Emergency" program assumes that sufficient time is available to create a large degree of short-run protection without unusual destruction of property or risk to life or health.

It may even be important to consider the possibility of mobilization taking place after a formal declaration of war. This possibility has not been seriously studied in the nuclear age, with its emphasis on sudden and decisive strikes. But it is worth recalling that World War II began with a "Phony War," which gave the French and the United Kingdom eight months of intense mobilization before their forces were seriously engaged. Even the surprise Japanese attack on Pearl Harbor was preceded by two years of tension and partial U.S. mobilization. Similar symbolic or inconclusive confrontations are far from impossible in future conflicts--in an era of mutual invulnerability they are relatively likely, at least as compared to sudden strikes. In such a situation, particularly if it involved a formal declaration of war, we might be willing, as in World War II, to devote up to half our GNP (about \$300 billion/year) to civilian and military defense purposes. Thus, if advance preparations had been made, one could easily imagine putting tens of billions into a nonmilitary defense program in less than a year.*

*Such a program would tap the readily deployable U.S. construction and other industries and agriculture. If extensive (and modestly expensive) preliminary preparations had been made, this nonmilitary defense program could be phased so as not to compete excessively with the military mobilization, much of which is necessarily slower.

If we believe that crisis scenarios represent an appropriate criterion for the design of a CD program, then it follows that the PF's (radiation protection factors) of the existing fallout shelters might be much improved during the period of great tension preceding any nuclear attack, because during the preattack crisis, when sufficient motivation presumably exists, the labor of something like 100 million people would be available to be applied towards increasing protection. To the extent that time is available and such labor is competently directed, a corresponding improvement in civil protection is possible. Thus, where people had not previously learned what needed to be done, a plan to educate and, perhaps, direct their activities during and subsequent to the crisis, could result in many lives saved, should a general war follow.

The relevance of the crisis contexts are crucial to this paper. Some of their implications for defense have been developed and applied previously (see Refs. 2 and 4) and now lead us to other applications discussed in Sections IV through VII. For example, Section VI discusses a concept that might be termed a dynamic approach to emergency civil defense planning. In it, the mobilization of the population for improvement of CD posture is visualized to begin during a tense period and to develop, as the threat materializes into war, through several "fallback positions," down to the last possible line of defense. (See Section VI, page 21.)

III. URBAN VULNERABILITY

Calculations of urban vulnerability to nuclear attack are usually made on the basis of primary nuclear effects, that is, blast damage, thermal shock, and radiation dose (both prompt and residual). In most moderate or large nuclear attacks these calculations alone give rise to estimates of at least tens of millions of casualties among the urban population, except for those CD programs which either provide very good blast shelters or move the vulnerable population out of target areas (e.g., see Ref. 4). Perhaps it belabors the vulnerability question unnecessarily to argue that urban survivors of the primary nuclear effects would also need to survive some secondary ones which may be created by combining more than one of the primary effects. However, since these secondary effects would cause some extra difficulties in an urban center struck by one or more groundburst nuclear weapons, we believe a short discussion may provide a useful perspective. Table II lists some of the important secondary effects which will be discussed below.

TABLE II

"Secondary" Sources of Urban Vulnerability

1. Fallout protection affected by:
 - window breakage
 - structural damage
 - fire damage
2. Long-term rescue affected by:
 - intense radiation fields
 - decontamination difficulties
 - egress from rubble covered shelters
 - transportation problems (littered streets, destroyed bridges)
 - communication difficulties
3. Health problems among "trapped" survivors
 - sanitation
 - diseases
 - food and water shortages
 - medicare
 - emotional stress
4. "Unexpected" Problems
 - flooding of basements
 - damage to ventilation systems

The first point in the table suggests that the PF's (protection factors) assigned to structures in peacetime may need to be degraded in wartime because of the possibility of blast or fire damage to the structures used as fallout shelters. Some fallout could enter a building since all the windows must be assumed to be shattered, thereby degrading the effective protection. Whether the degradation would be large depends

upon many variables such as the prevailing wind speed, the amount of window space, the original PF rating, and the location of the shelter in structure. One experiment using volcanic dust and based upon 5 mph wind speeds suggested that the entering fallout would only provide about 1/200 of the external intensity (Ref. 18).^{*} A much more pessimistic calculation, which arbitrarily assumed that because of window breakage each of the three floors of the Hudson Institute (a narrow 3-story building with large windows) was covered by 10 per cent of the external fallout density, reduced the PF in the basement from 100 to 30.

These two examples suggest a large range of uncertainty in the PF degradation due to window breakage. Larger buildings should be less affected than smaller ones. Shelters in basements should be less affected than those in upper stories. Better methods of estimating the hazard are still needed. However, the trend to an increasing percentage of the usable NFSS shelter spaces occurring in basements alleviates this problem somewhat.

Similarly, other structural damage from the blast wave would affect the ingress of fallout. If curtain walls are blown in, the PF degradation could be increased, in addition to other hazards created by the blast sweeping through the building. Recent blast damage calculations (Ref. 19) have taken 10 psi for the mean lethal overpressure. As a result of building damage and degradation of the PF's, one should add to the blast fatalities an increment of fallout fatalities in the zone of building damage (from about 3 to 20 psi) which would otherwise not exist.

Third, and possibly more important than structural damage by blast, is the threat of urban fires. If the protective facility caught on fire, a shelter area without special fire protection is likely to become unusable because of the heat or noxious fumes. This seems to be a substantial danger for many or most current shelter facilities identified through the NFSS. This danger does not need to assume that the cities would be destroyed by firestorms. Individual fires are often sufficient to make a building unusable as a fallout shelter. Papers which discuss the fire-fighting potential during the first 20-30 minutes after the blast tend to overlook the fact that the target area probably would be enveloped by a dense cloud of dust whose presence, together with the threat of imminent fallout and subsequent detonations, is apt to discourage firefighting. The great hazard from fire arises from the expectation that the affected people in burning buildings would probably be driven out into the debris-littered streets to try to find or improvise shelter just about the time when the intense early radiation arrives (assuming ground-burst weapons)--an exceedingly gloomy prospect. A recent OCD study estimated that about 25 per cent of the urban survivors of the prompt effects of a large nuclear weapon might be vulnerable to these consequences of fire (Ref. 19). Admittedly, the estimates of fire vulnerability are fraught with uncertainty since both fire ignition and

^{*}The results of this experiment are open to some argument because of a special geometry of the physical arrangements (an overhanging ledge) which would tend to hamper the ingress of falling particles.

spread are dependent on many parameters. Perhaps the 25 per cent estimate should range from 10 to 50 per cent.

The second major item of Table II suggests that if immediate survival must be followed by rescue within several days or weeks, the blast damage combined with relatively intense local radioactivity can make this an unusually difficult problem. It is not obvious that adequate help would come in time from outside the damaged urban centers. This would depend upon the details of the aftermath of the attack and could be quite sensitive to the existence of contingency plans and preparations.

The third category, which lists some possible health problems among the urban survivors, might not be a pressing matter in nontarget areas, but in combination with the general damage and (assumed) difficulties of external communication and assistance these could be severe. The emotional stress under the combined set of shocks suggested in Table II could well pose the greatest single hazard among survivors. The quantification of these hazards is a matter for future research, if indeed the problem is tractable.

The last category attempts to imagine the unexpected. Certainly there are likely to be some unexpected hazards. Because of building damage, rain or snow or water from damaged pipes may result in flooding of the basement areas. Basement shelters dependent upon vents or stairwells for ventilation might find these crushed or blocked by debris. Other possibilities of this kind will probably develop as the postattack environment is examined more intensively.

For the reasons listed above it may be pessimistic but should not be unreasonable to assume that for a medium-sized urban area (up to 200 sq. mi.) attacked by a groundburst weapon in the megaton range, the survival prospects without a blast shelter are so poor that they may be negligible (< 10%) as a first approximation. If the attack delivers more than one weapon to an area, survival becomes even more difficult. In large cities the prospects would seem to be even worse than in medium-sized ones, since, in the absence of good active defense, they are more likely to be struck by several weapons.

Our later attempt to describe fallout shelter improvements possible during or after a crisis which developed into a nuclear attack does not apply to target areas which would require shelters capable of surviving the blast, fire, and other close-in nuclear effects, in addition to heavy fallout. While adequate suburban blast shelters can be designed and built, given enough time and funds, they require plans, skills, and materials which are not expected to be available in the required quantities even in a few months (unless, of course, extensive preparations had been made in anticipation of such a situation--a context which is possible and perhaps advisable, but not considered in the present analysis).

IV. SPONTANEOUS DISPERSAL OF URBAN POPULATION

There are many historical examples of a large portion of a threatened population attempting to achieve a degree of protection by leaving the target areas (at least partly spontaneously) during a war or crisis. This happened three times in London, twice in 1938 and again in 1939 at the start of the war, and it happened in both Germany and Japan in the latter phases of World War II.

Thus we might be well advised to anticipate that during an extended escalating crisis many city people would find additional motivation for visiting friends and relatives in rural areas. It has been estimated, for example, that in New York City about 25 per cent of the city residents have relatives in the country.* Since some might invite close friends to join them, perhaps 40-50 per cent of the New York City population would have a place to go and might choose to relocate during a severe crisis (if there were no formal opposition by the government). The thought here is that in a crisis in which a nuclear attack became generally credible, unless a formal organized movement were ordered, some dispersal of the urban population would probably occur spontaneously. Thus, just at a most critical moment the civil defense organization could find itself in a position where, unless it took steps to integrate with and assist the voluntary movement, it might be "overrun" or at least seriously hampered in its planned activity. Indeed, if an exodus were begun by 10-20 per cent who had definite places to go, in some circumstances it might "stampede" the others to whom the alternative of remaining in the cities would suddenly appear more dangerous. In such situations the civil defense authorities could be faced with a dilemma. They would have the stocked NFSS shelters in the cities but might not be able reasonably or convincingly to claim that people would be safest there. It would be unfortunate if they were unable to function effectively because of a lack of preparations or rigidity of doctrine. Only if appropriate preparations had been previously developed could there be high confidence that options would be available to facilitate or restrain a spontaneous movement.

That local governments might be able to organize and effectively carry out a relocation within a few days under threatening circumstances has been made plausible by past experiences. For example, during Hurricane Carla in 1961 about a million residents of the affected Texas and Louisiana Gulf regions moved out of danger in an operation which was organized and developed in about two days (Ref. 6). Except for the meteorological information provided by the federal government, most of the important aspects of the movement were arranged by the local authorities. Outside assistance (U.S. Army, Red Cross, etc.) was considerable but was more directed toward providing welfare items, not the critical ingredients of the relocation which would change the life-and-death threat. The main point of using this historical incident is that effective survival measures often exist within the local

*For more detailed discussion, see Ref. 15.

capability, especially if authorities perceive the problem and understand the feasible options. For these options to be available in the event of a nuclear attack, local preplanning and preparations may be needed. This would imply the need for a more widespread understanding of the requirements for various emergency measures and a study of the technology required to make them feasible.

The current CD program which identifies shelters in existing buildings and other structures was originally designed for and undoubtedly would provide a great deal of protection in untargeted cities. While in recent years it seems that counterforce attacks have been considered increasingly important as nuclear war possibilities, nevertheless it is very difficult to imagine someone, during a crisis, accepting the risk that only a counterforce attack would occur, without greatly fearing an escalation into the more dire city attack. There is a tendency for people to believe that their locality would be subject to direct attack (Ref. 20).

If, on the other hand, only tactical warning of a nuclear attack, perhaps half an hour or so, were available to achieve some measure of protection, then the utility of the current program would seem to be relatively good. However, we have argued that the more probable outbreak scenarios would involve mounting international tension of at least several days, more likely weeks or months. These could permit both time for taking protective action and time for effective instruction to the population in emergency measures (see Ref. 7). Anticipating a nuclear attack, an intelligent citizen presumably would ask, "What choices do I have now." What alternatives would there be later if the threat gets worse?" These questions have been discussed among the staff at the Hudson Institute and in seminars with other research contractors. A frequent conclusion is that remaining in an urban center and planning to use one of the existing fallout shelters during any imminent nuclear threat would be an unlikely or unwise decision if at least a few days time were believed available and if some reasonable possibility for finding protection outside the city were perceived.

V. A BALANCED FALLOUT SHELTER PROGRAM*

The current program to survey, mark, and stock existing fallout shelter spaces in this country originally (phase 1) looked for shelter which would offer a PF of 100 or better, and subsequently, under the stimulus of the Cuban Crisis of 1962, was modified to include facilities whose PF was 40 or better (phase 2). These were very reasonable initial steps to take advantage of the existing protective resources within the country. We argue here that a logical third move would be to specify the minimum PF requirements of each locality in accordance with a reasonable doctrine of estimated need and use these specifications as a basis for determining future protective action.

For any assumed attack the minimum local fallout protection needed can be more or less accurately determined in terms of the physical parameters such as the distance from the targets and the probability distribution of wind variables which would determine the fallout pattern. In general, we would expect the calculations to show that areas near targets, especially in the prevailing wind directions, would require a greater amount of fallout protection than others more distant or in more favorable directions. The next step would be to make a judgment, based upon some chosen set of attacks and variation of other relevant parameters, of the required minimum protection at each locality.

Balancing PF Requirements

Typical fallout contours of a groundburst weapon of 1-MT fission yield (Ref. 5, p. 450) show some interesting numbers. These are reproduced in Table III, which gives the one-hour reference dose rate and the estimated two-week total dose of the areas between contours.

TABLE III

Dose Contours for a 1-MT Fission Groundburst

1-Hour Reference Dose Rate (r/hr.)	Area (Sq. Mi.) Within Contour	Area (Sq. Mi.) Between Contours	Est. Max. 2-Week Dose (r.)	PF Required (25 r. criterion)
3,000	140	140	~15,000	~600
1,000	420	280	8,000	320
300	900	480	2,500	100
100	2,200	1,300	600	2½
30	6,000	3,800	200	8
10	13,000	7,000	50	2
3	20,000	7,000	15	1

*The concepts of this section are more fully presented in Ref. 14.

One can observe from Table III that if an arbitrary criterion were adopted--that the dose accumulated during a two-week shelter period should be no more than 25 roentgens--the required levels of protection, as shown in the last column, would vary from a PF of about 600 down to a PF of 1. This degree of variation in PF requirements leads quite naturally to the idea of a "balanced program," one that would specify a minimum PF related to the estimated risk. For any assumed attack, this specification might vary by a factor of a hundred around the country, say from a PF of less than 10, which is currently available in most places, to a PF of 1,000, which would probably require separate construction or substantial improvement to existing facilities. By making appropriate computations it should be possible to map the United States into areas with associated radiation threat contours and suggest for each of these areas an appropriate minimum PF. The protection in some places might require PF's of only 5 or 10, while others might require PF's of 100, 200, or 1,000.

Because the PF requirements in counterforce attack contexts generally would be less than those needed for mixed attacks, it should not be an unreasonable guess that adequate shelter for the entire population against most counterforce threats already exists in the country, if some movement of the population is allowed. During an emergency, the problem would be for people to reach their designated shelters before the fallout arrived. The attainment of such a posture might involve both short-range (5-50 mile) dispersal movements and somewhat longer range (50-500 mile) evacuation from more threatened areas. (Those near military bases might relocate because of blast as well as fallout threats.) However, if we accept the idea that the more likely outbreak scenarios give at least days of warning, then the required movements seem to be generally feasible.

It has been suggested that achieving adequate civilian protection against most counterforce wars should not be difficult, mainly requiring preparation for balanced PFs and for timely movement of people to fallout shelter facilities. A more difficult problem would be to obtain an option for achieving adequate protection against the range of attacks in which some cities are targeted, perhaps during the later phases of a war. We argue that the same principle (i.e., calculating the minimum PF requirements for achieving balanced fallout protection) can be applied to this case, although the PF requirements usually would be more severe. For wars involving mixed attacks, it should be possible to calculate the resulting radiation contours at, say, the 95% probability level (i.e., 95% probability that the external dose would not exceed a stated amount). These contours could determine the minimum PF requirements and thereby serve as guides for using existing shelters in nontarget areas or otherwise planning for additional shelter.

For example, in a particular attack one might find that in Long Island, 30 or 40 miles from New York City, the radiation threat would require a minimum PF of 200, while for Bennington, Vermont, equivalent protection only requires a PF of 15. A balanced program based upon these

numbers would suggest that Long Island might need to move the part of its population that could not otherwise attain adequate PF's to other areas in which usable shelter existed or could be readily improvised. In this example, Bennington, Vermont, should have a substantial surplus of spaces, since nearly every house and commercial building has a basement with the required PF of 15. Thus, in this example, even without improving the existing shelters, some additional protection can be achieved by combining some movement with a judicious selection of reception areas. The numbers used above are, of course, hypothetical; more realistic ones can be determined by calculations using fallout models and a range of threats and attack patterns.

For most of the large urban centers an effective balanced fallout protection plan would probably require a combination of dispersal and improvised shelter if it were based upon very low-cost peacetime CD programs, such as we have today. Even as part of a planned program designed to bolster the more expensive "full fallout shelter" posture, during an emergency, a substantial amount of urban relocation and even some shelter improvisation might be required to achieve a balance (that is, a degree of fallout protection which reduces the risk from a given attack below a stated criterion, say, 5%). Some parts of the country, however, would be under much greater stress than others to achieve this balance. Some have a great number of special resources such as basements, mines, tunnels, caves or ships, while others tend to have relatively few of these resources (e.g., Los Angeles, San Diego, Tucson, Phoenix, Dallas, Houston, New Orleans and Atlanta). Thus, different amounts of time and preparations would be required in different localities to achieve equivalent protection--factors which could be taken into account in local emergency plans.

Near areas threatened by direct attack of several weapons, and therefore heavy radiation doses (up to about 100,000 roentgens), a properly balanced posture might require PF's of 1,000 or more to meet minimum standards. This would require a change in the current specifications which qualify a shelter if it meets the 40-PF criterion. Following an urban attack, a PF of 40 might be adequate for some of the more distant suburbs or those in directions away from prevailing winds, but not for many others. In some instances the changed specifications could be met by plans for increasing the protection factor of the facility during the emergency period. (A more detailed discussion of this is given in the next section.)

Indeed, a balanced fallout protection program, if developed on an over-all low-budget CD effort, undoubtedly would identify and plan to utilize the major existing suitable resources. An examination of some of the major resources is discussed in greater detail in Ref. 14. Included are (a) the NFSS facilities, (b) expedient shelter construction, (c) basements, (d) mines, tunnels and caves, and (e) inactive and active ships.

VI. DYNAMIC PLANNING FOR EMERGENCY CD

We can certainly imagine that just as there might be various levels of crisis developments (see Ref. 8), there might be levels of emergency responses of the civil defense system that increase the national readiness to cope with a nuclear attack. For well-directed efforts, most of the adult population could be employed to develop the CD posture, not only during a severe crisis but also during and subsequent to an attack, if necessary. This section discusses some of the possible measures for and consequences of such an approach to CD planning. The principle involved is that it is reasonable to expect people to be motivated to work hard to increase their survival chances when they are severely threatened, and to continue such efforts until the danger has been largely eliminated. This is a simple notion which has some important implications for CD planning.

During any serious crisis the civil defense organization would undoubtedly attempt to improve the existing posture to make up for any incompleteness of the previous peacetime effort and attempt to mobilize the necessary resources of the country to accomplish this end. If the improvements are not finished by the time an attack begins, the next interval for potential CD action occurs between receipt of tactical warning and the actual perception of the effects of a nuclear attack. During this time we would presume that rather frantic efforts would be made to attain whatever increase in protection could be had. The local CD system could disseminate special information via the avenues of communication that remain, in order to attain a high efficiency in these last hours (or days).

After shelter is actually taken in response to perceived nuclear effects, improving the PF's could often continue by inside work. The critical period would probably be the first few hours after an initial attack, perhaps from 2 to 8 hours. During this period there may be potential for increasing the PF of a shelter by a factor between 2 and 5, from which a substantial decrease in vulnerability might be achieved. Perhaps the next line of defense would be during the postattack efforts at rescue. For many localities the external environment during emergence from shelter could be much less hazardous if countermeasures were organized which appropriately employed (a) controlled exposure, (b) decontamination, and (c) relocation to safer regions.

Thus it is convenient to define four time periods during which both the shelter PF's and/or the number of shelter spaces might be increased. They are listed below and shown in Table IV.

- a. During the preattack crisis, or strategic warning period.
- b. After tactical warning is received (but before any fallout arrives).
- c. During the war, i.e., the shelter-stay period required by an attack.
- d. During the early emergence period when partial shelter is required.

TABLE IV
Dynamic CD Planning--Some Options

Peacetime: Contingency Preparations

Strategic Warning Period: (few hours to several months)

- Improve PF's of existing shelters
- Create expedient or improvised shelter
- Relocate vulnerable population
- Develop fallout removal systems
- Develop CD command and control systems
- Stockpile supplies for survival and recovery

Tactical Warning Period: (few minutes to few hours)

- Crowd better shelters
- Continue PF improvements
- Improvise relocation to better shelters

Attack Period: (few hours to few weeks)

- Create trenches, mounds, and "igloos" inside shelters
- Occupy better portion of shelter
- Local crowding in shelters for self-shielding
- Extend the stay-time in shelters

Emergence Period: (weeks or months)

- Relocate to safer areas
- Forage for additional supplies
- Use controlled exposure plan
- Decontaminate local areas

Recovery period: (months or years)

The possibilities for protective action during each of the intervals in Table IV are examined below. The measures found to be useful are not new; they are generally taken from previous OCD studies. What may be new is their application to time periods in which such activity has not often been contemplated.

Strategic Warning Period

This is the time period which has the greatest potential for protective action. The list reflects the possibility of improving the quality or quantity of shelters during the crisis and other opportunities for obtaining an improved CD posture. Its potential would depend greatly on the specific context. For example, if over a period of years we had installed the "full fallout shelter program," then because of the many rural shelters, during a tense period the need for additional shelter spaces for any relocated urban citizens would be considerably diminished (but not completely, e.g., see Ref. 3). On the other hand, with CD protection roughly as it is today, the situation may make clear the need for

improvised action. That the shelter posture could be improved during the preattack period is clear if one believes that there are likely to be several days, weeks, or months between the perceived beginning of the emergency and any subsequent attack. The interesting question becomes, "How large is the potential?"

A proper analysis of the potential for emergency protection in any particular locality would require an examination of its existing resources, and an estimate of the threats in reference to various possible enemy targeting. A previous study (Ref. 2) estimated that a reasonable degree of protection (survival probability > 90%) might be possible within seven days for nearly every United States civilian, if only rudimentary plans tailored to local resources and requirements had been made in advance.* This calculation assumed that citizens would respond to the suggestion of the authorities and would cooperate in the rapid construction of expedient community fallout shelters, even where it required some damage to existing property. In areas where blast threats seemed large, most people were to be sent to distant reception areas in which shelter could be improvised.

There are many ways that fallout protection could be improved during a crisis period. One might improve the PF's of the existing structures being used for shelters (a) by adding interior barriers against the expected external sources of radiation (e.g., placing masses of earth, water, or even ice against exterior walls, or on the floor above or below the shelter); (b) by devising methods for removing fallout particles from roofs (e.g., washdown or disposable sheeting), sidewalks or ledges; and (c) possibly by plowing or bulldozing around shelter facilities to create external radiation barriers.

These examples are meant to illustrate some of the possibilities; others would undoubtedly appear in local vulnerability studies. Thus, if at any community shelter facility one or more persons were knowledgeable about the fallout threat (or could become well informed during the emergency), then with the assistance from local citizens one would expect the knowledge to result in an improvement of the shelter.

It has been estimated (Ref. 2) that if minor property damage were tolerable it should not be difficult in most instances to convert a basement with a PF of 10 into a shelter with a PF of 100 or more, given one or more days' time and the labor of the occupants. If basement PF's could be increased from 10 to 100 or more, similarly, other fallout shelters could probably have their PF's increased, say, from 40 to 200 or more, or from 100 to several hundred. Recalling that to double the PF of a structure requires the interdiction of mass equivalent to about 3-1/2 inches of earth between the shelter and the major sources of radiation, the problem of doubling or quadrupling the protection does not seem likely to pose great problems, granting the availability of a day

*The referenced study assumes that (a) no attempt would be made to target rural reception areas and (b) the attack, if it comes, occurs soon after the planned emergency preparations were completed (and thereby avoids the problems which might develop with a long delay).

or so, a few resources (e.g., knowledge, organization, shovels), and the manpower (e.g., from the intended occupants of the shelter).

The current Government CD Program has plans to use existing structures for shelter where the PF is at least 40. Adding the potential from an emergency program would substantially increase the number of shelter spaces in nearly every locality, in some by large amounts. (Certainly, if every basement were considered to be a potential fallout shelter, then there could be very many more spaces than required.) Moreover, this potential seems to be large in rural areas and in or near most small towns--places where fallout protection is now most needed.

In localities where basements are not desirable or not available because of climate, local soil conditions, or building practices, other types of protective action may be available including short-range dispersal; long-distance evacuation; use of nearby mines, tunnels, ships and caves; or the construction of aboveground expedient shelter. Thus, without trying to exhaust the possible methods by which emergency protection can be obtained (a problem requiring additional research), it seems that a substantial potential exists: one which can greatly be enhanced through preparations on both a national and local basis.* (In a national program the DCD would probably wish to provide the concepts, the prototypes, technical assistance, and the incentive, while the local offices could do the investigations and create plans and preparations suitable to their resources.)

After Tactical Warning

The next time interval occurs after a locality has received tactical warning, but before fallout has arrived. In many scenarios this interval would provide several hours or more to most of the people (e.g., see Ref. 3). These hours can be especially important if we are imagining a place in which both (a) the amount and quality of existing shelter was inadequate, and (b) the preattack crisis was too short or too ambiguous for completion of the required emergency improvements. In such contexts, after the tactical warning signals were received, the citizens finding themselves with poor protection would need wise guidance. There may be some courses of action available, however, which would prove to be desirable, if not crucial.

For example, one simple tactic of great potential is the "overcrowding" of the better completed shelters. As an illustration, if in a particular locality at the time tactical warning is received, standard shelter spaces were available for only 40% of the population, the local authorities might choose to put 60, 80, or even 100% of the population into these shelters, reducing to a minimum the population for which other solutions were needed. It has been argued (Ref. 9) that frequently

*For more quantitative estimates, see Ref. 14.

shelters might be overcrowded by a factor of 2 or 3 without great risk to the lives of the occupants. The tolerable degree of crowding would, at the limit, depend on circumstances, more crowding being possible in the winter than in the summer, more in the North than in the South, and more where water is flowing than where it is stored. A harsh choice may need to be made in some extreme cases in attempting to balance the increased health hazards to the overcrowded occupants against the risk of leaving some without good shelter. The most important aspect of the overcrowding tactic is that local authorities understand the option in the event a need arises. In cases requiring overcrowding by less than 100%, the decision-maker's choice may often be easy if he is able to think about it in advance.

The time available between the tactical warning signal and the arrival of fallout might be as much as several hours (in some cases, even days) depending upon the nature of the war, the prevailing meteorological conditions, and the direction and distance of nearby targets. Thus, in many places continuing emergency action until the first arrival of fallout is sensed could add substantial protection. The measures for reducing the radiation threat to any shelter could be similar to those mentioned in the previous section. Indeed, if we assume that the plans for utilizing the preattack crisis period were insufficient, the brief interval after tactical warning could prove critical. Preparations to advise people when and how to continue improving their CD posture where an extra hour or two or five were available for final efforts could provide a useful option. It could be used to improve some shelters or advise movement to shelter in adjacent towns or nearby mines, ships, caves, tunnels, cellars and basements (or even barns in areas where relatively little fallout was anticipated).

Thus, a dynamic civil defense plan would have local options which are geared to the nature of the crisis, degrees of preparation, and the wisdom of the local civil defense organization to improvise the greatest amount of protection in accordance with the perceived circumstances right up to the time the fallout actually arrives. Where necessary for the next line of defense, that is after tactical warning is received, work could continue from inside the shelters. This is the subject of the following section.

The Shelter Period

After sizable attacks many shelters might be occupied continuously for one or two weeks, perhaps a month. Could the occupants profitably use this time to decrease their vulnerability? What are the potential actions? These will vary according to the local environment, but a number of widely applicable possibilities seem to exist. For example, in a basement shelter the floor might be dug up (in some cases requiring a sledge hammer and a few shovels) and earth scooped out of the floor (or the walls) and used to make protective mounds and trenches which might increase the PF by a factor of 5 or more.

There are also some simple tactics which would enable people to get an extra protection factor of 2 or 3 without digging. For example, one would find that if the average protection factor of a basement were 10, the protection factor near some of the walls or corners might be between 15 and 20. This could be determined by monitoring if the technical information were unavailable. If these more protected areas were occupied by clustered groups, there would be some additional self-shielding. These two actions alone could give an extra protection factor of about 3. A basement whose nominal PF is 10 thereby becomes a shelter with a PF of 30. (See Ref. 10 for a more quantitative discussion.)

The concept being emphasized is that where it is believed that the radiation level might be lethal or dangerous, the logical response would be to work on improving the protection while opportunities exist. Before any fallout arrives at an improvised shelter, it is presumed that people could bring shielding material and other supplies such as tables, chairs, lumber, and nails which could be useful subsequently. In some cases the interior walls of buildings might even be torn down for construction materials. Also, of course, tools such as sledge hammers, shovels, saws and picks would be valuable and undoubtedly collected from available sources. Occupants might erect barriers against radiation arriving through windows or thin walls, they might build interior "igloos," and they could plan ways to remove fallout particles from roofs and ledges or any sifting-in through the ventilation system.

If there is danger of lethal exposure within the shelter, the added protection must be achieved relatively quickly. For example, if the fallout arrives about four hours after a nearby nuclear explosion, the occupants of the shelter would receive about 25% of the total exposure during the next eight hours, another 25% during the next four days. Thus they would have something between a few hours and a few days to do something effective--and more like a few hours than a few days. If nothing were done for the first three or four days, then subsequently at best, one could reduce the total exposure by a factor of 2. If effective action were taken within the first hour or two after the fallout arrived, the total exposure might be reduced by an additional factor of 5 or more. Referring to the above example, during the first two hours after the fallout arrives, about 10% of the total dose would be delivered. (The data on exposure is taken from Ref. 5, page 429.)

One can easily imagine that during the shelter period, after having observed the evidence of bombs going off and learning of a radiation threat, the shelter occupants would be very interested in reducing the anticipated hazard and that the shelter manager and/or other authorities would be expected to offer sound advice and assistance. For an illustration let us look at a hypothetical case. Assume for one design that the minimum requirement in Bennington, Vermont, is a PF of 15 and that Bennington is found to have enough basements with an estimated PF of at least 15 to accommodate quadruple the existing population without any serious distress. Assume, also, that after an attack, because of uncertainties Bennington turns out to be a hot spot (relatively) and that the PF required to prevent serious casualties is found to be 40, not 15. If the

basement shelters had not been improved during the crisis some casualties would occur. This threat could be partially alleviated by efforts at shelter improvement between the receipt of tactical warning and the time the fallout arrived, as was discerned earlier. Finally, by using the in-shelter techniques discussed above, it might be possible to increase the protection by a factor of from 3 to 5, and the effective PF for most of the Bennington area might actually turn out to be more than the minimum required. Only among those who fail to achieve this extra protection would there be potential casualties.

In areas of high radioactivity it might be desirable to extend the nominal shelter period for a few days or weeks. While it is frequently presumed that because a shelter has been stocked with food for two weeks it could only be occupied for two weeks, this conclusion is too pessimistic. Most people could survive on water alone for about a month. Certainly, if a two-week food stockpile were rationed to last an additional week or two because this extra time would substantially improve the chances of survival, it would seem to be a wise choice. Using an assumption that emergence must occur after the nominal shelter period increases the estimated casualties. Additional time in shelter reduces the threat both because of the additional radiation decay and the increased probability of receiving outside assistance. It enhances the possibility of organizing an effective postattack movement to safer areas; in other cases, survivors in shelters might receive additional information and supplies to sustain them until an appropriate phasing out can begin. It seems clear that the potential of contingency plans developed for these options is significant. The feasibility and cost of appropriate plans and preparations require further study.

The Emergence Period

The shelter period may be said to be ended when occupants begin to spend a portion of each day outside the shelter. Studies have suggested that, to prevent undue exposure, the phasing of people out of shelter living would generally follow a controlled procedure. The control of radiation exposure during the emergence period is reasonably well understood and has been discussed in several places (e.g., see Ref. 11). It is a technical matter mostly requiring an understanding of radioactive decay and the relationship between acute or chronic doses and the probability of illness (or fatality). However, in localities with very intense radioactivity, where this procedure would not be reasonably possible at the end of the nominal shelter period, occasional brief exposures of an hour or two for some occupants might permit a replenishment of supplies without too seriously endangering their health or strength. By this means, the nominal shelter period might be extended somewhat, after which, upon emergence, it might be necessary to limit the initial daily exposure to very small intervals. In such severe circumstances effective decontamination might not be feasible for several weeks or months after emergence.

Techniques of decontamination have been developed over a number of years (for example, see Refs. 11 and 12) and are reasonably well understood. The problems of decontamination in a targeted urban area would be much more severe than in undamaged places, for which reason they are usually specifically excluded in decontamination studies.

Where the external environment is very severe, it is probable that after initial emergence the shelterees would wish to seek a less dangerous haven. Fallout patterns suggest that frequently, by short movements of 10, 20 or 30 miles in an appropriate direction, external radiation intensities can be reduced by factors of 10 to 100. Thus, the effective use of monitoring and communications could, after a time, be used to encourage or assist those in highly radioactive locations to move to less hazardous areas. The ability to monitor effectively, transmit the appropriate messages, perhaps arrange for transportation assistance, and develop suitable reception areas probably would be dependent on preparations made prior to the attack. An examination of several fallout charts for attacks ranging up to 20,000 megatons has indicated that a postattack movement offers a potential for greatly reducing the long-term threat to those "trapped" in the relatively "hot" areas. Situations in which this capability would seem desirable include movement from:

1. local "hot spots";
2. areas where decontamination is difficult because of the physical damage, the lack of appropriate decontamination equipment, or the lack of skilled manpower;
3. areas where severe health problems develop, even though the radiation threat might otherwise be manageable (these problems might include epidemics, shortage of medical or sanitation supplies, or shortage of medical facilities or trained personnel);
4. areas where food or water (or other supplies) are inadequate or where the transport to replace supplies would be more difficult to provide than moving the people;
5. areas where communication or transportation bottlenecks cannot readily be restored, thus preventing effective post-attack clean-up or reconstruction. The survivors would be more useful in other parts of the country.

In the first four situations above, we would anticipate that many casualties could be avoided. The fifth is one in which the recovery would be assisted by the relocation.

A dynamic CD program would prepare options to continue the fight for survival whenever and wherever it is possible, including the postattack recovery period. Serious planning for postattack assistance to survivors

has not yet developed, although there have been rumblings of developing interest for taking this type of preparation seriously (Ref. 13).

We should be somewhat cautious about counting upon the success of postattack efforts of this type without a great deal of prior thought and a working out of the details appropriate to many possible postattack situations. The possibility of damage on the unprecedented scale suggests that extrapolations from past examples of the behavior of people during disaster might not be appropriate. For example, while we know that after a peacetime disaster it is natural for a convergence of outside assistance to develop, it is not at all clear that this can be anticipated should a major portion of the country be damaged in a nuclear war. If potential rescuers did not adequately understand the nature of the threats or of the required emergency actions, early postattack assistance is apt to falter badly. Suitable plans and preparation would seem first to require studies which can anticipate the more important needs of relevant postattack contexts. Some typical questions needing answers are: How could millions of voluntary rescuers be organized among a people frightened, bereaved, and beset with new unprecedented daily threats and family responsibilities? How could the early distribution of food and fuel to needy areas be effected if the commercial system is in temporary chaos? To what extent, postattack, would survivors share their remaining resources with refugees if it placed them and their families in some jeopardy?

Resources for Recuperation

Important activities possible during a crisis, especially if plans were made to assist the effort, include emergency preparations for both the immediate postattack recovery and the long-range recuperation. For example, if an extreme crisis should last for two weeks, enabling a response of greater scope than mere flight or improvised shelter construction, in many areas the available time could be used both by householders and by commercial and industrial establishments to protect valuable but vulnerable equipment. For example, rolling equipment might be moved and stored away from areas threatened by blast. Thus, loaded trucks, trains, ships and automobiles filled with supplies and equipment could be put into improvised temporary storage depots. Sensitive or expensive equipment could be moved into basements of buildings not needed for fallout shelters and insulated to give some shock protection. This could make it possible for some of the property to survive in the lower range of blast overpressures. Certainly, such valuables as manufacturing procedures, engineering drawings, and vital legal records could readily be protected.

To make a crude estimate, one could argue that some 20 million automobiles and some 5 million trucks and busses, each loaded with valuables, could provide a basic stockpile worth perhaps \$50-100 billion, and that it might be created in a few days' time. To be sure, this

stockpile would not be completely balanced, in that it probably would not consist of the most useful postattack supplies and equipment. However, where there are choices, selections of this kind could be improved as a result of last-minute guidance. For example, during the emergency, authoritative suggestions through radio and television programs or printed leaflets or newspaper stories would encourage people to establish priorities of survival items based upon previous research findings. It may subsequently prove to be of great importance for a person to have known which to protect first: his radio and television sets, books, furniture, tools, clothes, groceries, legal papers, gardening equipment, medical supplies, art objects, electrical appliances, or hunting and fishing equipment. It would seem to be useful to encourage such a study.

VII. LOW-CASUALTY DESIGNS

It was mentioned earlier that a fallout shelter program could be enhanced by first determining the minimum PF requirements in accordance with some reasonable estimates of probable threats. Thus, fallout protection needed near a target area might require a PF of 100 to 500, while in a more distant place equivalent protection would require PF's of, say, from 10 to 50. These systems would assume that the protected population would not be subjected to the direct effects of a nuclear attack. Thus, the distant suburban and rural populations and the relocated urban citizens by assumption would be subjected only to collateral damage, not to the effects of deliberate targeting.

This raises a basic distinction between postures designed to alleviate the damage of optimized malevolent attacks against the protected population and those designed to alleviate the consequences of attacks against military and/or city targets. The latter postures are concerned with the collateral damage from a counterforce attack and the direct damage from an urban attack but, because of technical constraints or voluntary restraint, assume that the non-urban areas are not targeted. Such a targeting policy might occur (a) because an attacker chooses to maximize property damage to the urban-industrial area; (b) because he is constrained by rigidity of pre-existing war plans or doctrine; (c) because the lack of timely information prevents a recalculation of targeting which would maximize the damage (such a calculation would need to be based upon distribution of population and property and the degree of protection available at the time of attack); or (d) because of existing tacit (or formal) agreements about the conduct of nuclear warfare.

This issue raises the question of whether CD systems should be designed to anticipate the most malevolent enemy attack or whether they ought to meet the requirements of preventing collateral damage in untargeted areas, assuming the major urban centers are included in the likely targets. We argue that for the reasons given above (and others*) it is unlikely that the complex most-malevolent targeting is to be expected. This is an important point bearing on our claim that even with inexpensive programs, casualties might be held to astonishingly low levels in mixed attacks involving several thousand delivered MT, if the weapons are not purposely detonated over outlying reception areas. That is, if the assumption is valid, the use of urban relocation and rural shelters could be very effective in preventing fatalities.

A basic difference between designing postures to reduce collateral damage and designing those which minimize the damage from direct attacks is that it is possible, in principle, for the former to completely eliminate fatalities. That is, as far as the design is concerned, fatalities

*For example, in many scenarios city attacks occur in later phases of the war after more than one counterforce exchange. In these scenarios it is usually very difficult to control the residual forces with the flexibility required for "last minute" targeting changes (e.g., see Ref. 17).

would only result from the "noise" in the system (the unplanned or unanticipated developments). For example, if the program fails to obtain the planned protective facilities, if people fail to take the best available shelter, if the attack exceeds the maximum prepared for, if a "freak meteorology" occurs or an "unknown" effect appears, then additional casualties may occur. Otherwise they have been circumvented by design of the system and the range of applicable scenarios.

Within the budget, the time constraints, and for the range of scenarios to be considered, the problem of the system designer is to devise a feasible protective plan which, if properly implemented, theoretically would prevent casualties. Of course, a zero-casualty performance cannot be attained, but as a goal it provides a standard which can lead to effective designs. This orientation can also help a designer to spell out quantitatively the reasons why his system fails to meet the zero-casualty criterion. In this way the problems requiring solution should be clearly delineated.

To sum up, low-casualty designs are likely to be based upon the following assumptions and planning factors:

1. Without blast shelters urban survival prospects are very poor for cities that are attacked (see page 11). Therefore, citizens in potential target areas should either have plans for good blast protection or for timely movement to distant shelter.
2. Preparations for fallout shelter would be based upon a balanced fallout protection concept (see page 17) and a specified range of scenarios for which the system provides protection. In each locality these preparations would be backstopped by a set of options (see page 21) to ameliorate the inevitable difficulties during implementation that cannot be anticipated.
3. Reasonable plans and preparations in response to the requirements for postattack assistance, relocation, and decontamination can be developed.
4. Plans and preparations for coping with the longer term problems of health, social reorganization, government, and economic recovery would be developed in parallel with the survival plans (but these are not being examined in this paper).

Any CD design can only cope with a restricted range of war scenarios. Generally, this range will be larger with greater budgets. When more funds are available for CD, then less emergency improvisation should be required and in a crisis available time presumably can be more efficiently utilized. Therefore, less warning time is needed to achieve a given posture, which increases the confidence in the system. Also, with more preparations the probability is improved of greater effectiveness in using the options of a flexible or dynamic program based upon successive lines of protective measures (see page 22).

The low-cost CD designs based upon the zero-casualty concept would require city people to relocate to more distant shelter facilities during a severe crisis. Therefore, the saving in peacetime CD preparations would imply greater social and economic costs at any time the program is actually implemented. These costs may prove to be many times that which would be involved in a normal program and have little legacy value. Nevertheless, larger deferred costs may be preferred to substantial current ones both because of the hope that the need will not arise and because obsolescence of any current system might be appreciable within several years, requiring another round of expenditures (as is customary in military systems).

VIII. CD EFFECTIVENESS

Calculation of estimated fallout fatalities can be efficiently performed today on electronic computing machines, but existing models generally do not reflect the complex possibilities of integrated and dynamic CD systems. For example, depending on parameters, a typical model might assign something between two days and two weeks as the shelter stay time and, with an assumed set of PF's, make some rigid assumptions as to the degree of exposure after emergence from the shelter. In practice, such decisions would more reasonably be made in accordance with a judgment based on the perceived threats and available options, and is apt to be very complex. Also, existing models are not programmed to shift the population in accordance with the anticipated threat and the local capability to improvise protection.

From some of the arguments in earlier sections of this paper we would like to suggest below some ways in which future casualty estimates could be improved, and which we believe would reflect a greater degree of reality and show more effectiveness in the functioning of civil defense during an emergency:

1. Assume 99-100% occupancy of prepared shelters: As long as the scenario contains several days of strategic and/or tactical warning (which we assume is reasonable) it is excessively conservative to assume that after receipt of tactical warning a large portion (like 5, 10 or 20%) of the population would have taken much poorer shelter than that locally available. We would suggest between 0 and 1% as more reasonable. The possibility of everyone having to respond to very short warning (less than one hour) which leads to difficulty in obtaining nearby shelter, otherwise available, should not be totally ignored but should be given attention as an off-design possibility, not as the central case.

2. Prepare to overcrowd higher quality shelters: For less expensive programs (with an insufficient number of existing shelters), a degree of overcrowding of the better shelters available in many parts of the country can be used to improve the posture substantially. Where the risk of a city attack is believed too great, a partial dispersal of the urban citizens to suburban or rural shelters which can be overcrowded might be contemplated. A computational model should have such options fed into its representation of the sheltered configuration.

3. Develop local options for relocation of urban citizens: In many places movement to more distant rural areas, where there is greater safety from the blast and fire effects, would be better than dispersing people from the central cities to the suburbs to build expedient shelter. Because of lower PF requirements, the rural areas often can provide a greater degree of fallout protection. Also, in much of the country the required time for this movement is less than one day.

4. Improve existing shelters during a strategic warning period: It would be reasonable to assume that for many interesting cases (e.g., those in which days of strategic warning are available) special stockpiling preparations, including additional food or other supplies, would be made and

shelter improvements could be accomplished which would either increase the shelter PF before an attack or give an increased potential for staying longer in the shelters should the need arise. Thus the overall effective PF's used in calculations would be higher than those assigned in peacetime and should be estimated by a computational model.

5. Estimate the utility of the options of a dynamic CD program:

Flexible plans to improve the civil defense posture through emergency shelter construction and/or improvisation by means of emergency education and mobilization of the resources and labor in the country during the several periods from the initial crisis through the postwar period might often be used to great advantage. With such a program the national CD posture improves with time once a sufficiently tense crisis occurs. This improvement should be estimated and reflected in the calculations. It should be related to the details of the war scenarios.

6. Utilize the balanced fallout protection criteria: The use of an emergency CD posture based on the balanced fallout protection concept should give an improved degree of fallout protection. This would require changes in both the distributions of the peacetime population and an assignment of PF's in accordance with the local minima specified by the criteria.

7. Limit fallout casualties by effective postattack plans: Assuming that CD techniques of postattack relocation, decontamination and/or controlled exposure are feasible leads to the general conclusion that if a person can survive the first 2-4 weeks within a shelter and receive less than about 200 roentgens, he has a very high probability of surviving the subsequent effects of radiation. It is assumed, of course, that there would also be a reasonable system for monitoring radiation and communicating the information, thereby clarifying the threat and the options for surviving it. Thus, except for the cheapest or most poorly implemented programs, reasonable-to-good survival prospects can be expected for those who are not casualties during the initial weeks.

The point above suggests that the larger civil defense programs would prepare to assist or rescue any survivors "trapped" in very severe environments. We wish to distinguish between the usual rescue concept (a rescuer rushes into a collapsed building and pulls the woman out from beneath the fallen beams before the fire envelops her) and that necessary for survivors of nuclear blast and fallout who might require decontamination, supplies, or postattack relocation, but not necessarily within minutes or hours--possibly not within days. Essentially the race will be between the rescue and starvation, thirst, or possibly disease; these threats generally are matters of days, if not weeks. A theory of effective rescue is needed to estimate the immediate postattack casualties.

8. Estimate urban vulnerability to secondary effects: The action of blast and thermal effects of nuclear explosions upon urban structures tends to destroy or to degrade the protection offered by urban fallout

shelters. In addition, there are a number of special problems related to health, entrapment, communication, transportation, and external assistance requirements which seem to be especially severe for the survivors in attacked urban centers. Thus, people in the attacked cities would seem to be more vulnerable than has usually been estimated heretofore, unless they are protected by special blast shelters.

REFERENCES

1. Brown, William M., et al., Changing Prospects, Missions and Roles for Civil Defense: 1965-1975, HI-447-RR, Hudson Institute, Harmon-on-Hudson, N.Y., February 22, 1965.
2. Brown, William M., Strategic and Tactical Aspects of Civil Defense with Special Emphasis on Crisis Situations, HI-160-RR, Hudson Institute, Harmon-on-Hudson, N.Y., January 7, 1963.
3. Dustin, Sara, The Civil Defense Counterpart to a 1973 Nuclear War Scenario, HI-391-RR, Hudson Institute, Harmon-on-Hudson, N.Y., January 7, 1965.
4. Brown, William M., Alternative Civil Defense Programs and Postures, HI-361-RR/1, Hudson Institute, Harmon-on-Hudson, N.Y., June 11, 1964.
5. Glasstone, S., editor, Effects of Nuclear Weapons, Atomic Energy Commission, Washington, D.C., April, 1962.
6. Treadwell, Mattie E., Hurricane Carla, September 3-14, 1961, Department of Defense, Office of Civil Defense, Region 5, Denton, Texas, December 1961.
7. Kahn, Herman, et al., Increasing Damage-Limiting Effectiveness Through Emergency Readiness and Mobilization Capabilities, HI-461-RR(Rev.), Hudson Institute, Harmon-on-Hudson, N.Y., December 28, 1964.
8. Kahn, Herman, On Escalation: Metaphors and Scenarios, HI-392-RR/Rev., Frederick A. Praeger, New York, 1965.
9. Krupka, Robert A., Overcrowding Potential, HI-361-RR/4, Hudson Institute, Harmon-on-Hudson, N.Y., June 11, 1964.
10. Childers, H.M. and H.S. Jacobs, Identification and Analysis of Post-attack Exposure Control Countermeasures, General Technologies Corporation, Alexandria, Virginia, June 15, 1964.
11. Miller, Carl, Fallout and Radiological Countermeasures, Stanford Research Institute, Menlo Park, California, 1963.
12. Owen, W.L., Radiological Recovery of Land Target Components--Complex I and Complex II, United States Naval Radiological Defense Laboratory, San Francisco, California, 1962.

13. Greene, Jack C., An Introduction to the Problems of Postshelter Radiation Exposure Control (3rd Draft), Department of the Army, Office of Civil Defense, Washington, D.C., 1964.
14. Rockett, Frederick C. and William M. Brown, An Analysis of Local Protection Factor Requirements and Resources, HI-486-RR, Hudson Institute, Harmon-on-Hudson, N.Y., August 2, 1965.
15. Iklé, Fred C. and Harry V. Kincaid, Social Aspects of Wartime Evacuation of American Cities, National Academy of Sciences, National Research Council, 1956, p. 49.
16. Ahlers, Edward B., Debris Clearance Study, ITT Research Institute, Chicago, Illinois, September 1963.
17. Rubinow, Shirley, et al., The Performance of Some U.S. Defense Postures in Various 1970 General Wars (U), HI-384-RR, Hudson Institute, Harmon-on-Hudson, N.Y., September 28, 1964, SECRET.
18. Soule, R.R., Studies of Volcanic Fallout Related to OCD Problems--Phase I, Ingress Through Open Windows, U.S. Naval Radiological Defense Laboratory, San Francisco, California, May 1, 1964.
19. U.S. Department of the Army, Office of Civil Defense, The Damage-Limiting Potential of CD Programs (U), Washington, D.C., August 1, 1964. SECRET.
20. Edelsberg, John S., et al., Knowledge and Attitudes Concerning Civil Defense Among Residents of the Washington Metropolitan Area, Operations Research Office, The Johns Hopkins University, Bethesda, Maryland, August, 1958, p. 22.

DOCUMENT CONTROL DATA - R&D		
(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)		
1 ORIGINATING ACTIVITY (Corporate author) HUDSON INSTITUTE Harmon, New York		2a REPORT SECURITY CLASSIFICATION Unclassified
		2b GROUP
3 REPORT TITLE A NEW LOOK AT THE DESIGN OF LOW-BUDGET CIVIL DEFENSE SYSTEMS		
4 DESCRIPTIVE NOTES (Type of report and inclusive dates) Research Report 1965		
5 AUTHOR(S) (Last name, first name, initial) BROWN, WILLIAM M.		
6. REPORT DATE AUGUST 2, 1965	7a. TOTAL NO. OF PAGES 38	7b. NO. OF REFS 20
8a. CONTRACT OR GRANT NO. OCD-PS-64-116	9a. ORIGINATOR'S REPORT NUMBER(S) HI-478-RR	
b. PROJECT NO.		
c. Task No. 4211-B	9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
d.		
10. AVAILABILITY/LIMITATION NOTICES Distribution unlimited. Copies available from DDC, Cameron Station, Alexandria, Virginia.		
11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY Department of the Army	
13 ABSTRACT <p>The feasibility of designing highly effective low-cost C.D. systems is examined in relationship to various war outbreak scenarios and the utility of the associated preattack warning period. It is argued that with moderate confidence such highly effective systems can be designed. They would depend upon a general mobilization of civilian resources during an emergency to greatly expand and improve any existing C.D. capability. Ideally such designs can visualize attaining the goal of zero casualties; however, a dynamic plan would contain several options to handle the many imperfections which would almost certainly appear during implementation.</p> <p>The essential elements of the C.D. designs are examined separately for technical, political, administrative, and strategic feasibility. It is concluded that this approach offers substantial promise for future C.D. developments.</p>		

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Civil defense systems Civil defense budgets Urban vulnerability Zero casualties Scenarios Evacuation Civil defense research International crisis Fallout shelter programs Civil defense estimates Balanced fallout protection Recuperation Dynamic planning						

INSTRUCTIONS

1. ORIGINATING ACTIVITY: Enter the name and address of the contractor, subcontractor, grantee, Department of Defense activity or other organization (*corporate author*) issuing the report.

2a. REPORT SECURITY CLASSIFICATION: Enter the overall security classification of the report. Indicate whether "Restricted Data" is included. Marking is to be in accordance with appropriate security regulations.

2b. GROUP: Automatic downgrading is specified in DoD Directive 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional markings have been used for Group 3 and Group 4 as authorized.

3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified. If a meaningful title cannot be selected without classification, show title classification in all capitals in parenthesis immediately following the title.

4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.

5. AUTHOR(S): Enter the name(s) of author(s) as shown on or in the report. Enter last name, first name, middle initial. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.

6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.

7a. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.

7b. NUMBER OF REFERENCES: Enter the total number of references cited in the report.

8a. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.

8b, 8c, & 8d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.

9a. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.

9b. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers (*either by the originator or by the sponsor*), also enter this number(s).

10. AVAILABILITY/LIMITATION NOTICES: Enter any limitations on further dissemination of the report, other than those

imposed by security classification, using standard statements such as:

- (1) "Qualified requesters may obtain copies of this report from DDC."
- (2) "Foreign announcement and dissemination of this report by DDC is not authorized."
- (3) "U. S. Government agencies may obtain copies of this report directly from DDC. Other qualified DDC users shall request through _____."
- (4) "U. S. military agencies may obtain copies of this report directly from DDC. Other qualified users shall request through _____."
- (5) "All distribution of this report is controlled. Qualified DDC users shall request through _____."

If the report has been furnished to the Office of Technical Services, Department of Commerce, for sale to the public, indicate this fact and enter the price, if known.

11. SUPPLEMENTARY NOTES: Use for additional explanatory notes.

12. SPONSORING MILITARY ACTIVITY: Enter the name of the departmental project office or laboratory sponsoring (*paying for*) the research and development. Include address.

13. ABSTRACT: Enter an abstract giving a brief and factual summary of the document indicative of the report, even though it may also appear elsewhere in the body of the technical report. If additional space is required, a continuation sheet shall be attached.

It is highly desirable that the abstract of classified reports be unclassified. Each paragraph of the abstract shall end with an indication of the military security classification of the information in the paragraph, represented as (TS), (S), (C), or (U).

There is no limitation on the length of the abstract. However, the suggested length is from 150 to 225 words.

14. KEY WORDS: Key words are technically meaningful terms or short phrases that characterize a report and may be used as index entries for cataloging the report. Key words must be selected so that no security classification is required. Identifiers, such as equipment model designation, trade name, military project code name, geographic location, may be used as key words but will be followed by an indication of technical context. The assignment of links, rules, and weights is optional.

HUDSON INSTITUTE

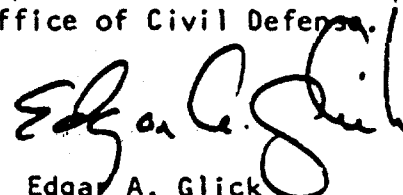
QUAKER RIDGE ROAD, HARMON-ON HUDSON, N. Y. 10520 CABLE ADDRESS: HUDSON, N. Y. 10520

November 29, 1965

Memorandum for Addressee

Subject: Change of Title Page and Label for Front Cover

Please change the title page of your copy of HI-478-RR, "A New Look at the Design of Low-Budget Civil Defense Systems," to delete the sentence that reads: "Copies of this report may be obtained from Defense Documentation Center, Cameron Station, Alexandria, Virginia, 22314." Also, please attach enclosed label to the front cover of the report. We have been requested to make the above change by the Office of Civil Defense.


Edgar A. Glick
Publications Officer

AD 622-096